

What is claimed is:

1. A method of modifying a shock wave in a gas, comprising the steps of:  
emitting energy along an extended path in the gas;  
heating gas along the path to form a volume of heated gas expanding outwardly from the  
path; and

5 directing the path whereby the volume of heated gas passes through the shock wave and  
modifies the shock wave.

2. The method according to claim 1, wherein the energy is deposited along a stream line  
ahead of a bow-shock created by the movement of a body through the gas.

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3. The method according to claim 1, further comprising the step of changing the  
direction of movement of a body through the gas.

4. The method according to claim 1, wherein the step of emitting the energy along the  
15 extended path reduces the density of the gas which is heated by the energy, thereby causing  
lateral movement of the gas away from a volume in the gas to which the heating energy is  
applied.

5. The method according to claim 1, wherein the step of emitting the energy along the  
20 extended path reduces the density of the gas which is heated by the heating energy, thereby  
reducing drag on a body while the body maintains a non-zero angle of attack relative to the gas.

6. The method according to claim 1, wherein the step of emitting the energy along the  
extended path reduces the density of the gas which is heated by the heating energy, thereby  
25 reducing the temperature on a portion of a body to reduce damage to the portion.

7. The method according to claim 1, wherein the step of emitting the energy along the  
extended path reduces the density of the gas which is heated by the heating energy, thereby  
reducing the pressure on a portion of a body to reduce damage to the portion.

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8. The method according to claim 1, further comprising the step of directing an amount of the gas into a propulsion system, wherein the step of heating the gas controls the amount of fluid being directed into the propulsion system.

35           9. A method of reducing a shock wave in a gas, comprising the step of:  
selectively discharging a heating energy in the gas ahead of the shock wave to form an extended heated path through the shock wave, wherein the heating of the gas simultaneously at different points forms the extended heated path.

40           10. The method according to claim 9, wherein the heated path is formed along a stream line ahead of a bow-shock created by the movement of a body through the gas.

          11. The method according to claim 9, further comprising the step of changing the direction of movement of a body.

45           12. The method according to claim 9, wherein the step of discharging the heating energy reduces the density of the gas which is heated by the heating energy, thereby causing lateral movement of the gas away from a volume in the gas to which the heating energy is applied.

50           13. The method according to claim 9, wherein the step of discharging the heating energy reduces the density of the gas which is heated by the heating energy, thereby reducing drag on a body while the body maintains a non-zero angle of attack relative to the gas.

          14. The method according to claim 9, wherein the step of discharging the heating energy  
55 reduces the density of the gas which is heated by the heating energy, thereby reducing the temperature on a portion of a body to reduce damage to the portion.

          15. The method according to claim 9, wherein the step of discharging the heating energy reduces the density of the gas which is heated by the heating energy, thereby reducing the  
60 pressure on a portion of a body to reduce damage to the portion.

16. The method according to claim 9, wherein the step of selectively discharging a heating energy in the gas further includes the steps of:

discharging an ionizing electromagnetic radiation in the gas to form a conductive path;

65 and

discharging an electric discharge along the conductive path.

17. The method according to claim 16, wherein the heated path is formed along a stream line ahead of a bow-shock created by the movement of a body through the gas.

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18. The method according to claim 16, further comprising the step of changing the direction of movement of a body.

19. The method according to claim 16, wherein the step of discharging the heating energy reduces the density of the gas which is heated by the heating energy, thereby causing lateral movement of the gas away from a volume in the gas to which the heating energy is applied.

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20. The method according to claim 16, wherein the step of discharging the heating energy reduces the density of the gas which is heated by the heating energy, thereby reducing drag on a body while the body maintains a non-zero angle of attack relative to the gas.

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21. The method according to claim 16, wherein the step of discharging the heating energy reduces the density of the gas which is heated by the heating energy, thereby reducing the temperature on a portion of a body to reduce damage to the portion.

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22. The method according to claim 16, wherein the step of discharging the heating energy reduces the density of the gas which is heated by the heating energy, thereby reducing the pressure on a portion of a body to reduce damage to the portion.

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23. A method of reducing a shock wave in a fluid by selectively discharging a heating energy in the gas ahead of the shock wave to form an extended heated path through the shock wave, comprising the steps of:

discharging an ionizing electromagnetic radiation in the gas to form a conductive path,  
95 the ionizing electromagnetic radiation including UV laser pulses, visible laser pulses, IR laser pulses, and/or combinations thereof; and

discharging energy along the conductive path, the energy different from the ionizing electromagnetic radiation, wherein

the extended heated path is formed by the heating of the gas simultaneously at different  
100 points.

24. The method according to claim 23, wherein the energy is an electric discharge.

25. The method according to claim 23, wherein the energy is microwave energy.

26. The method according to claim 23, wherein the energy is laser energy.

27. The method according to claim 23, wherein the fluid is a gas.

28. An apparatus on a body moving through a fluid for modifying a shock wave formed in the fluid by the body, comprising:

means for emitting energy along an extended path in the fluid; and

means for heating fluid along the path to form a volume of heated fluid expanding outwardly from the path, wherein the means for emitting energy includes a filamenting laser and  
115 a microwave emitter;

whereby the volume of heated fluid passes through the shock wave to modify the shock wave.

29. A method of decreasing drag of a body passing subsonically along a direction  
120 through a fluid, comprising the steps of:

emitting energy along an extended path in the fluid;

heating fluid along the path to decrease the density of fluid around the path and to form a volume of heated fluid expanding outwardly from the path; and

directing the path parallel to the direction the body passes through the fluid,

125        wherein the body passes through the volume of decreased-density heated fluid and  
whereby the reduction of density of the fluid decreases the drag on the body, and  
the heating of the fluid at different points along the path occurs simultaneously.

130        30. The method according to claim 29, wherein electromagnetic energy heats the fluid  
along the path.

31. The method according to claim 29, further comprising the step of repeating said steps of emitting energy, heating fluid, and directing the path.

135        32. The method according to claim 29, wherein multiple paths are formed within the  
fluid.

33. A method of decreasing drag of a body passing subsonically along a direction through a fluid, comprising the steps of:

140        emitting energy along an extended path in the fluid;

heating fluid along the path to decrease the density of fluid around the path and to form a volume of heated fluid expanding outwardly from the path; and

directing the path parallel to the direction the body passes through the fluid,

145        wherein the body passes through the volume of decreased-density heated fluid and  
whereby the reduction of density of the fluid decreases the drag on the body, and wherein the  
fluid includes a liquid.

34. A method of decreasing drag of a body passing subsonically along a direction through a fluid, comprising the steps of:

150        emitting energy along an extended path in the fluid;

heating fluid along the path to decrease the density of fluid around the path and to form a volume of heated fluid expanding outwardly from the path;

actively changing a direction of the path through the fluid; and  
directing the path parallel to the direction the body passes through the fluid,  
155 wherein the body passes through the volume of decreased-density heated fluid and  
whereby the reduction of density of the fluid decreases the drag on the body.

35. The method according to claim 34, wherein the step of heating the fluid causes  
lateral movement of the fluid away from an area in the fluid to which the energy is applied.

160 36. A method of steering a body traveling subsonically through a fluid, comprising the  
steps of:

emitting energy along an extended path in the fluid;  
heating fluid along the path to form a volume of heated fluid expanding outwardly from  
165 the path;  
directing the path to asymmetrically change pressures exerted against the body, thereby  
steering the body.

170 37. A projectile having a body, comprising:  
a propulsion system;  
an inlet for the propulsion system;  
means for emitting energy along an extended path in a gas ahead of the projectile; and  
means for heating fluid along the path to form a volume of heated fluid expanding  
outwardly from the path, wherein the means for heating fluid controls an amount of fluid  
175 entering the inlet.

38. The projectile according to claim 37, wherein the propulsion system is a scramjet.

180 39. The projectile according to claim 37, wherein the propulsion system is a turbine  
engine.

40. The projectile according to claim 37, wherein the inlet is symmetrically positioned  
around the body.

185           41. The projectile according to claim 37, wherein the inlet is non-symmetrically positioned on the body.

          42. The projectile according to claim 37, wherein the means for emitting energy includes an aerodynamic window.

190           43. A method of decreasing drag of a body passing transonically along a direction through a fluid, comprising the steps of:

          emitting energy along an extended path in the fluid;  
          heating fluid along the path to decrease the density of fluid around the path and to form a  
195 volume of heated fluid expanding outwardly from the path; and  
          directing the path parallel to the direction the body passes through the fluid,  
          wherein the body passes through the volume of decreased-density heated fluid and  
whereby the reduction of density of the fluid decreases the drag on the body, and  
          the heating of the fluid at different points along the path occurs simultaneously.

200           44. The method according to claim 43, wherein electromagnetic energy heats the fluid along the path.

          45. The method according to claim 43, further comprising the step of repeating said steps  
205 of emitting energy, heating fluid, and directing the path.

          46. The method according to claim 43, wherein multiple paths are formed within the fluid.

210           47. A method of decreasing drag of a body passing transonically along a direction through a fluid, comprising the steps of:  
          emitting energy along an extended path in the fluid;  
          heating fluid along the path to decrease the density of fluid around the path and to form a  
volume of heated fluid expanding outwardly from the path; and

215 directing the path parallel to the direction the body passes through the fluid,  
wherein the body passes through the volume of decreased-density heated fluid and  
whereby the reduction of density of the fluid decreases the drag on the body, and wherein the  
fluid includes a liquid.

220 48. A method of decreasing drag of a body passing transonically along a direction  
through a fluid, comprising the steps of:  
emitting energy along an extended path in the fluid;  
heating fluid along the path to decrease the density of fluid around the path and to form a  
volume of heated fluid expanding outwardly from the path;  
225 actively changing a direction of the path through the fluid; and  
directing the path parallel to the direction the body passes through the fluid,  
wherein the body passes through the volume of decreased-density heated fluid and  
whereby the reduction of density of the fluid decreases the drag on the body.

230 49. The method according to claim 48, wherein the step of heating the fluid causes  
lateral movement of the fluid away from an area in the fluid to which the energy is applied.

50. A method of steering a body traveling transonically through a fluid, comprising the  
steps of:  
235 emitting energy along an extended path in the fluid;  
heating fluid along the path to form a volume of heated fluid expanding outwardly from  
the path;  
directing the path to asymmetrically change pressures exerted against the body, thereby  
steering the body.

240 51. An apparatus on a body moving through a fluid for modifying flow of the fluid,  
comprising:  
means for emitting energy along an extended path in the fluid;  
means for heating fluid along the path to form a volume of heated fluid expanding  
245 outwardly from the path, and



an aerodynamic, window,  
whereby the energy is directed through the aerodynamic window to heat the fluid and  
modify the flow.

250            52. A method of decreasing drag of a body passing along a direction through a fluid,  
comprising the steps of:  
              emitting energy through an aerodynamic window along an extended path in the fluid;  
              heating fluid along the path to decrease the density of fluid around the path and to form a  
volume of heated fluid expanding outwardly from the path; and  
255            directing the path parallel to the direction the body passes through the fluid,  
              wherein the body passes through the volume of decreased-density heated fluid and  
whereby the reduction of density of the fluid decreases the drag on the body, and  
              the heating of the fluid at different points along the path occurs simultaneously.

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